

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in Electrical and Electronic Apparatus

We, SHORT BROTHERS & HARLAND LIMITED, a British Company, of Seaplane Works, Queens Island, Belfast, Northern Ireland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described, in and by the following statement:—

The object of this invention is to provide an improved form of package for electrical and electronic apparatus, or for component sub-units thereof, hereinafter referred to comprehensively by the term "unit", whereby such units or an assemblage thereof may conveniently be stowed in compartments or containers provided therefor, for example, in vehicles, aerodynes, missiles or the like, for the control of which such units may be required.

According to the invention such units are packaged by assembling the components of the unit together with all leads and conductors by which the components are connected, in their operational positional relationship, preferably in the smallest convenient compass. The assemblage is placed in a mould which is then filled with a liquid thermo-setting synthetic resin containing a foam-producing ingredient capable of liberating and dispersing a gas throughout the liquid and thereby converting the latter into a lightweight foam which, on setting will constitute a rigid support capable of preserving the components of the unit against relative displacement. After setting of the foamed resin, the unit is placed in a second mould providing a narrow space around all the surfaces thereof, which space is filled with a thermo-setting hard resin which is cured to form a high density protective skin of durable characteristics.

In the case of a unit incorporating thermionic valves these may be housed in a drilled metal block which is mounted at one

side of the package so that the valves are segregated from the remaining components.

The manner in which the invention may be carried into effect, as in the manufacture of an electric unit for incorporation in the control apparatus of a guided missile, is hereinafter described with reference to the accompanying drawings. In the drawings:—

Fig. 1 is a perspective view of the components of the unit assembled in the position in which it is desired that they should be packaged.

Fig. 2 is a similar view of the assembly on conclusion of the first stage in the encapsulation process, i.e. after removed from the first mould, and

Fig. 3 is a further perspective view of the unit in its finished condition, where it is ready for installation in the missile.

Fig. 4 is an end elevation of the compartment of a missile in which units such as that shown in Fig. 3 are stowed between the outer skin and an axial tube enclosing a cavity which may be used to contain a thermal battery.

The unit exemplified in Figs. 1 to 3 consists of an assemblage of a segmental aluminium alloy-block B, in which are drilled a plurality of housings B₁ for the reception of thermionic valves V, together with a number of panels P (e.g. P₁, P₂ and P₃) between which are supported the several components C. Said panels P are made of copper-clad plastic laminate, etched to form the required circuits incorporating the several components C and the valves V, and then jig-drilled or punched to form holes required for mounting the components C and for the passage therethrough of lengths of conductor wire W which connect terminals on said components to the etched circuits and also the circuits of the respective panels. The terminals T of certain of the components, and the ends of

the wires W, project through the upper panel P₁ so as to be accessible for subsequent connection to leads from another unit. The edges of the panels P₁ and P₂ contiguous to the block B may be located in slots B₂.

The first stage of the packaging process is carried out by placing the assembly shown in Fig. 1 in a mould having an internal shape which corresponds to that of the desired sub-unit, but with somewhat smaller overall dimensions than the latter and having an interior lining of sheet rubber provided with a facing material such as that which is sold under the name Melinex (Registered Trade Mark). The whole of the unfilled spaces surrounding the components C and between the panels P₁ and P₂, and between the panel P₂ and the underside of the block B is filled with a liquid thermo-setting resin containing a foaming agent, which on setting will constitute a rigid matrix FR which is capable of preserving the components against relative displacement. The mould used for the final packaging stage which gives the sub-unit its desired exterior dimensions (Fig. 3), and the spaces surrounding the outer surfaces of the first-stage package foamed resin FR and the upper side of the panel P₁, are filled with a synthetic resin of high durability, so as to form a hard skin SR of approximately $\frac{1}{10}$ inch thickness.

In Fig. 4 the reference letter H denotes the cylindrical metal casing of the compartment of a missile. A plurality of sub-units packaged in the manner hereinbefore described may be assembled in said compartment about an axially disposed cavity AC which is reserved for housing a thermal battery, the circumferential dimensions of the several sub-units being such that the total included angle between radial inter-faces is 360°. Spacer dummy units may be inserted as at SD. The convex outer walls of the valve blocks B make contact with the inner wall of the casing H, providing good thermal conductivity to ensure effective cooling characteristics. Lengths of soft corrugated aluminium tube Q may be inserted in the valve containers B₁, so as to support the glass envelope of the valves firmly therein and thereby ensure effective heat transfer to the outer casing H.

This method of packaging electronic and analogous apparatus is advantageous for the reasons (a) that the weight of the package is very low, (b) that it ensures efficient thermal insulation of the components from heat gener-

ated by the valves, (c) that the mechanical stresses imposed upon the components by differential rates of expansion is low, and (d) that the hard durable outer skins of the units can be metal-sprayed for screening purposes, as at S.

It will be understood that the block B may be used to house transistors, in place of the valves V, or other components.

WHAT WE CLAIM IS:—

1. A package for electrical or electronic apparatus, or for component sub-units thereof, wherein an assembly of several components in their operational positional relationship, together with leads and conductors by which the components are connected, is encapsulated in a thermo-setting synthetic foamed resin which is itself enclosed in a skin of thermo-setting hard resin of high density.

2. A package as claimed in Claim 1, wherein the assemblage of components includes a metal block including drilled housings for thermionic valves, transistors or the like, and a plurality of spaced panels between which the components are secured, said panels being drilled to receive conductor leads connecting the components.

3. A package as claimed in Claim 2, wherein the panels are made of copper-clad plastic laminate etched to form circuits to which the ends of the conductors and terminals of the components are bonded.

4. A package as claimed in any one of the foregoing claims, which is of such shape and dimensions as to be capable of being housed together with other similarly shaped packages in a cylindrical missile compartment about an axial cylindrical cavity, so that the outer wall of the valve block makes contact with the inner wall of the compartment for ease of heat dissipation.

5. The method of manufacturing a packaged electrical or electronic apparatus, which consists in assembling the several components of the apparatus in a mould having an internal shape corresponding to that of the desired sub-unit but of smaller overall dimensions than the latter, filling the spaces surrounding the components with foamed synthetic resin, and afterwards enclosing the latter in a second moulding operation with a skin of high density thermo-setting resin.

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PROVISIONAL SPECIFICATION

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We, SHORT BROTHERS & HARLAND LIMITED, a British Company, of Seaplane Works, Queens Island, Belfast, Northern

Ireland, do hereby declare this invention to be described in the following statement:—

The object of this invention is to provide

an improved form of package for electrical and electronic apparatus, or for component units thereof, hereinafter referred to comprehensively by the term "unit", whereby such units or an assemblage thereof may conveniently be stowed in compartments or containers provided therefor, for example, in vehicles, aerodynes, missiles or the like, for the control of which such units may be required.

According to the invention such units are packaged by assembling the components of the unit, together with all leads and conductors by which the components are connected, in their operational relationship, preferably in the smallest convenient compass. The assemblage is placed in a mould which is then filled with a liquid thermo-setting synthetic resin containing a foam-producing ingredient capable of liberating and dispersing a gas throughout the liquid and thereby converting the latter into a light-weight foam which, on setting will constitute a rigid support capable of preserving the components of the unit against relative displacement. After setting of the foamed resin, the unit is placed in a second mould providing a narrow space around all the surfaces thereof, which space is filled with a thermo-setting hard resin which is cured to form a relatively high density protective skin of durable characteristics.

In the case of a unit incorporating thermionic valves these may be housed in a drilled metal block which is mounted at one side of the package so that the valves are segregated from the remaining components. Said block may be used to carry etched circuit connections between which the several components may be mounted in well-known fashion.

In a particular embodiment of the invention, as applied to an electronic unit for incorporation in the control apparatus of a guided missile in which the compartment provided for such unit is a cylindrical annulus enclosing an axial cavity containing a thermal battery, the unit is divided into sub-units having radially disposed interfaces including angles of 36° or multiples thereof.

The metal block forming the valve container is made of aluminium alloy and to it are attached copper-clad laminated panels etched to form the circuit connections for the unit. The panels are disposed so as to lie longitudinally of the unit and parallel to each other. The units are arranged side by side to form an annulus concentric with the cylindrical compartment in which the units

will be housed. The panels are first jig-drilled to form the holes required for mounting certain of the components and connections between the etched circuits of the panels are made by soldering lengths of conductor wire across the edges thereof. The valves are wired directly into the etched circuits.

The convex walls of the valve blocks make contact with the inner face of the cylindrical housing, providing good thermal conductivity to permit effective cooling characteristics. Lengths of soft corrugated aluminium tube may be inserted in the valve containers, so as to support the glass envelopes of the valves firmly therein and ensure heat transfer to the outer panel.

The first stage of the packaging process is carried out in a mould of an internal shape corresponding to that of the desired sub-unit, but with somewhat smaller overall dimensions than the same and having an interior lining of sheet rubber provided with a facing material such as that which is sold under the name Melinex (Registered Trade Mark). The whole of the unfilled space between the panels and between the compartments mounted on the inner side of the innermost panel is filled with foam synthetic resin. The mould used for the final stage gives the sub-unit its desired final exterior dimensions, the spaces surrounding the outer surfaces of the first-stage package being clad in a hard skin of a synthetic resin of high durability, of approximately $\frac{1}{16}$ inch thickness.

A plurality of sub-units packaged in the manner here described may be assembled in the missile compartment about the axially disposed cavity reserved for the thermal battery, the circumferential dimensions of the several sub-units being such that the total included angle between radial inter-faces is 360° .

This method of packaging electronic and analogous apparatus is advantageous for the reasons (a) that the weight of the package is very low, (b) that it ensures efficient thermal insulation of the components from heat generated by the valves, (c) that the mechanical stresses imposed upon the components by differential rates of expansion is low, and (d) that the hard durable outer surfaces of the units can be metal-sprayed for screening purposes.

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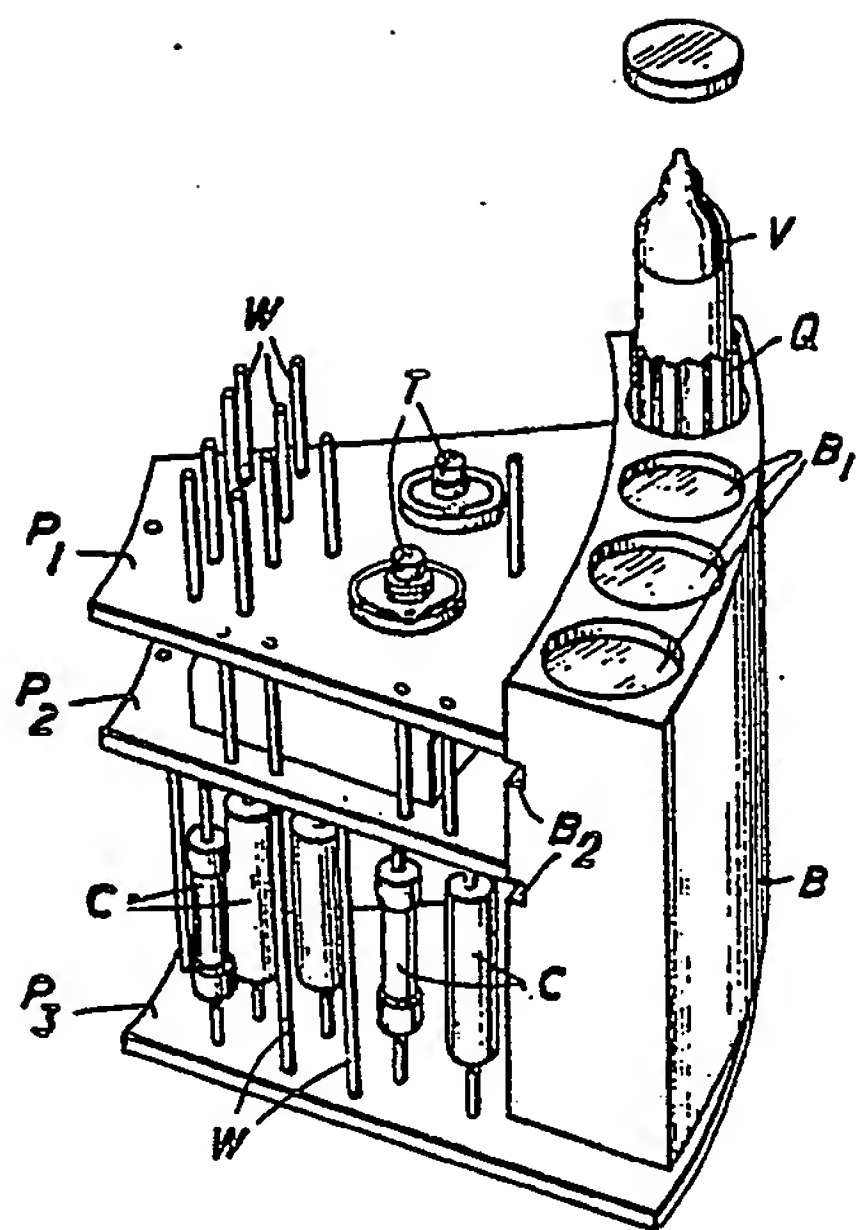


Fig. 1.

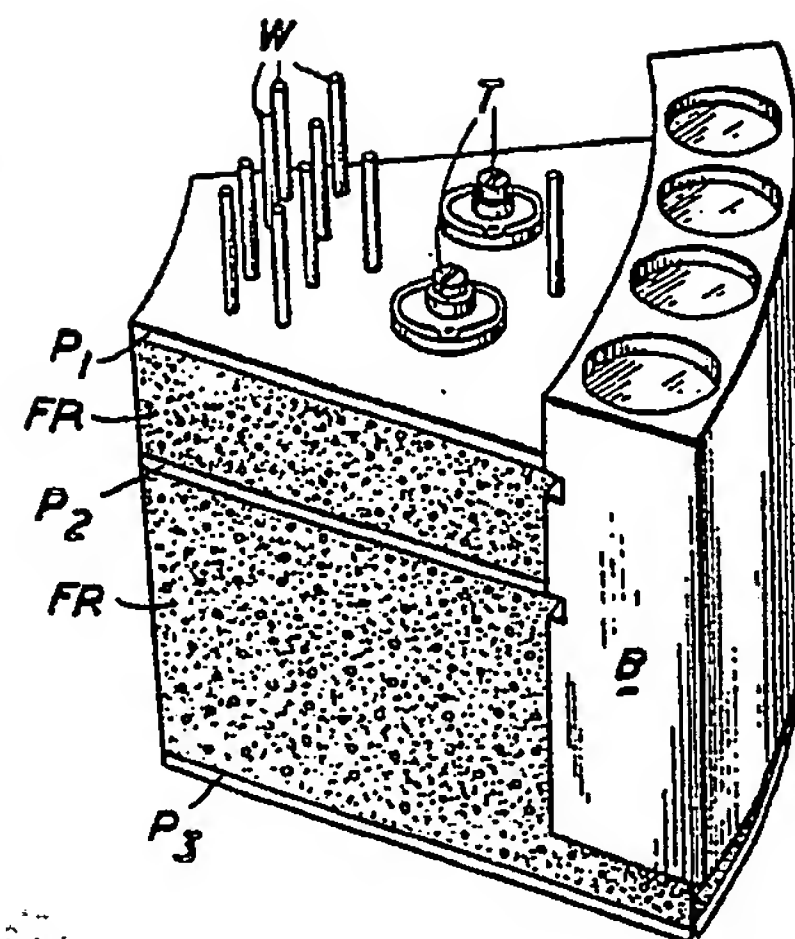


Fig. 2.

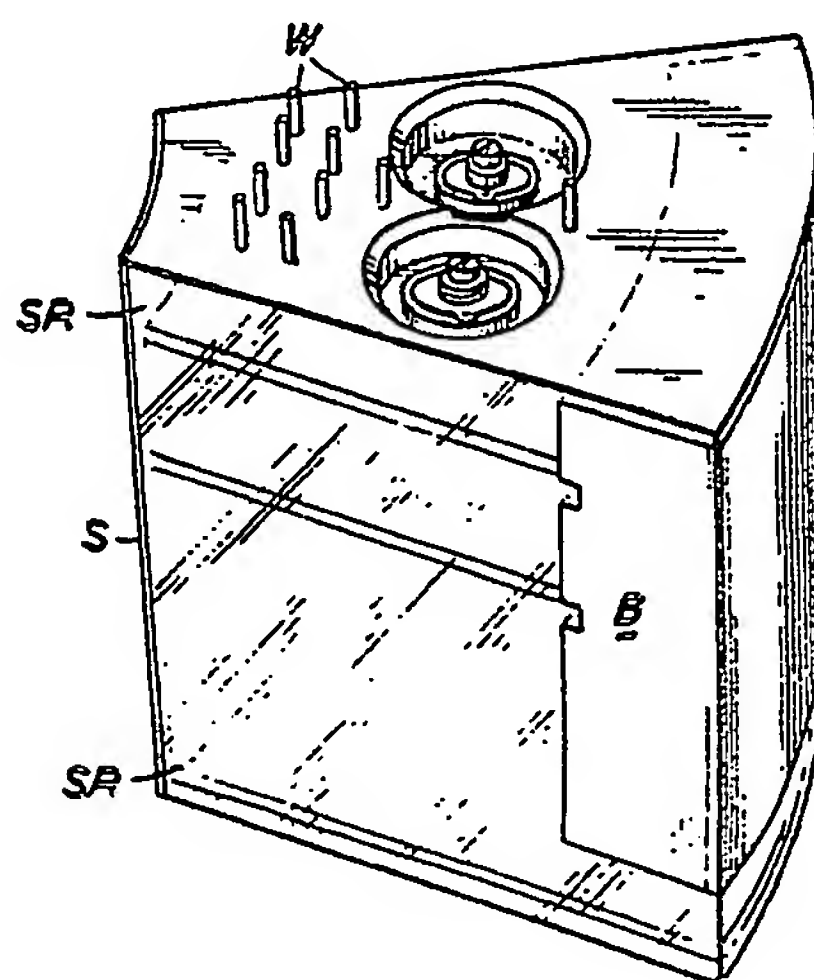


Fig. 3.

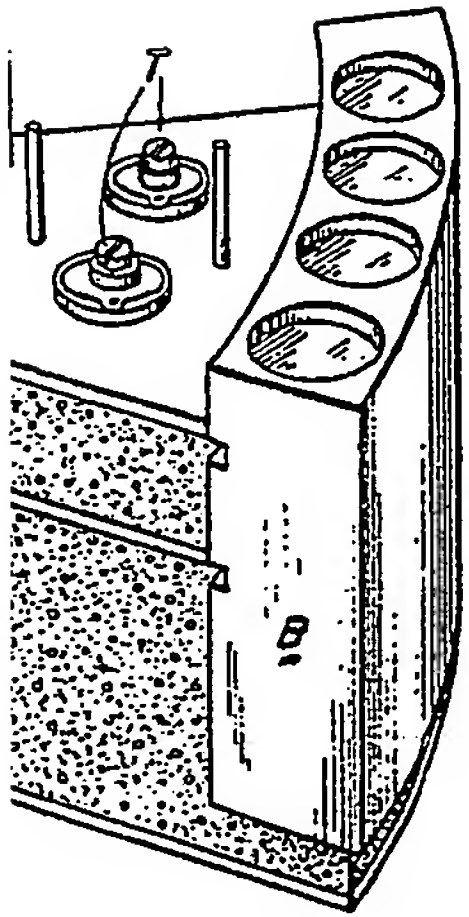


Fig. 2.

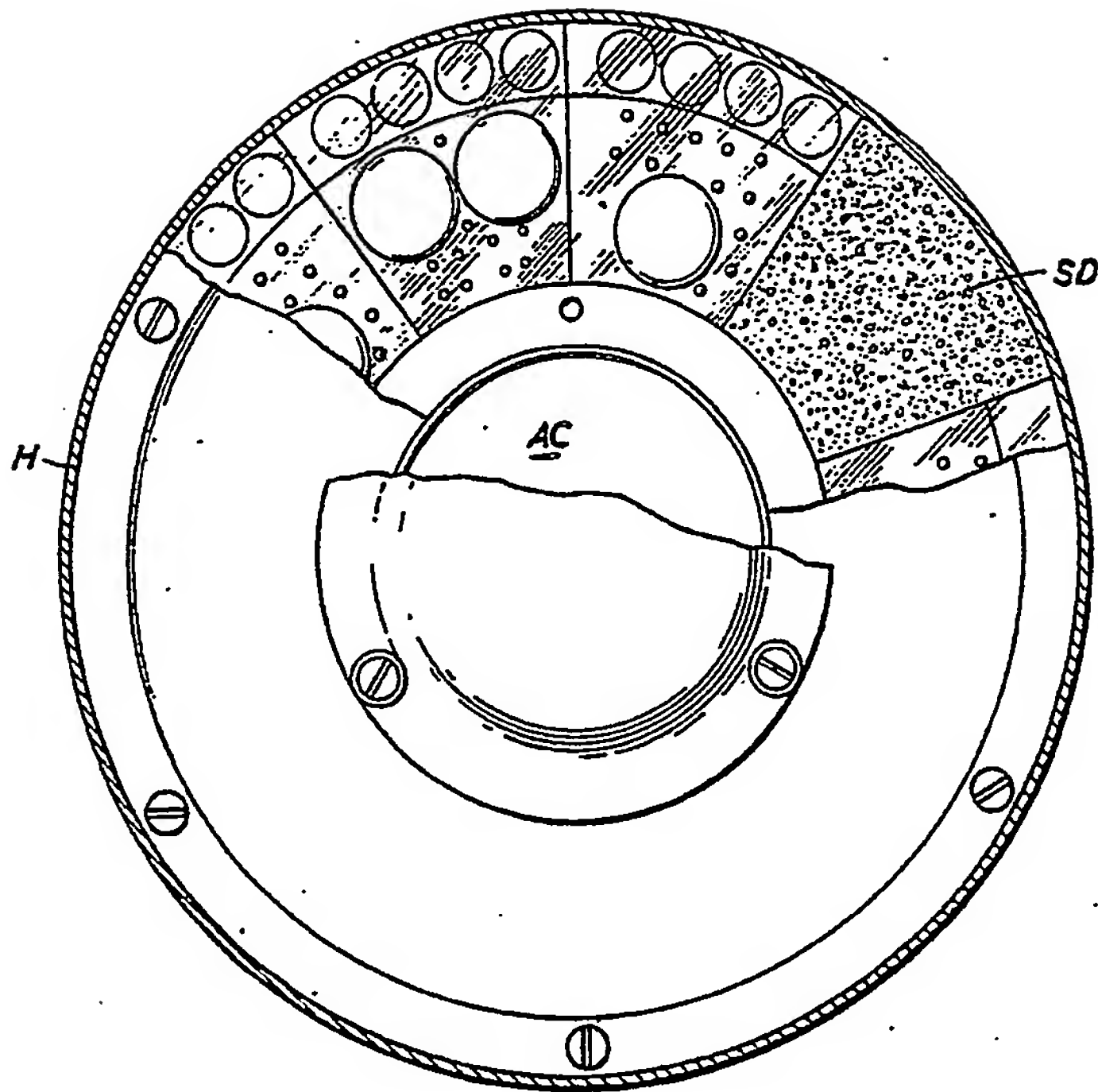


Fig. 4.

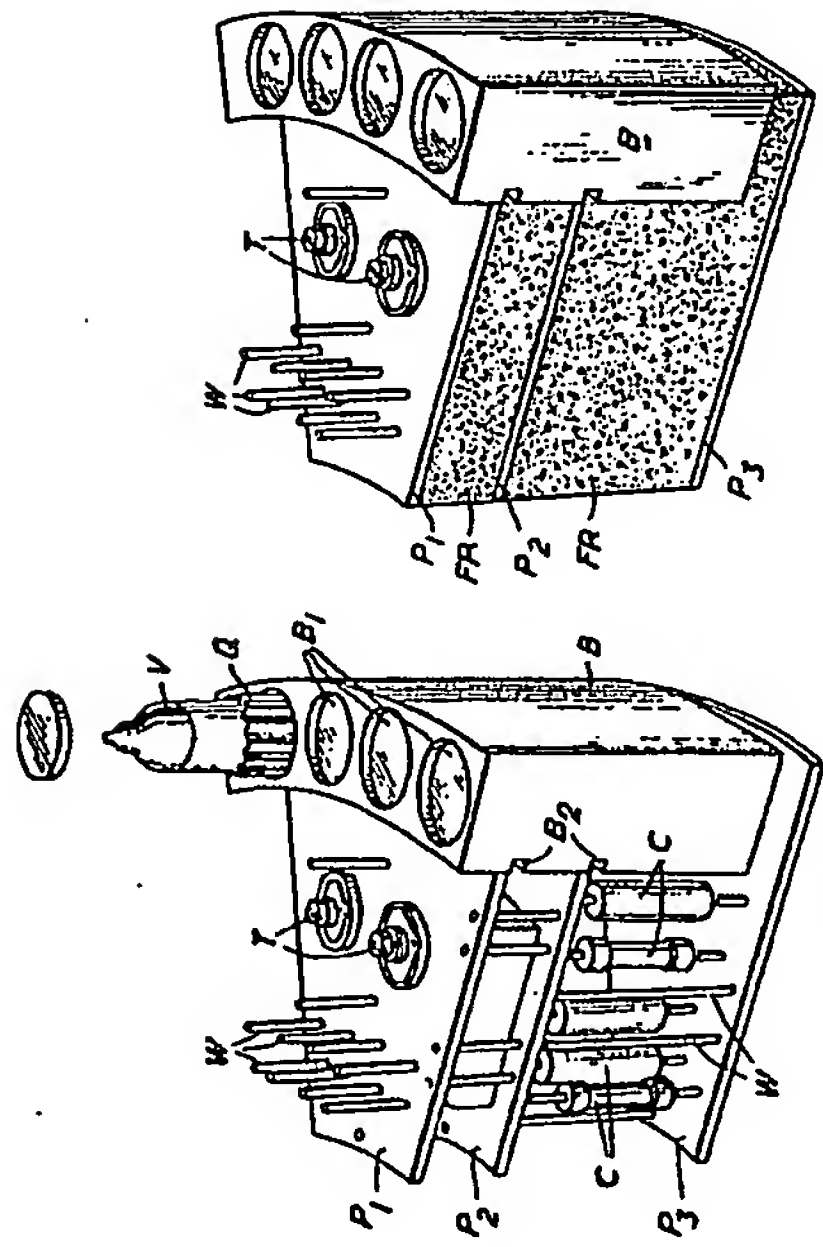


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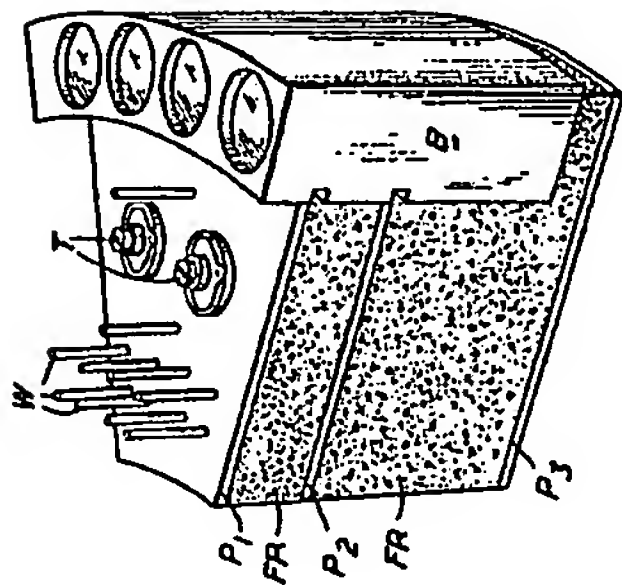


Fig. 2.

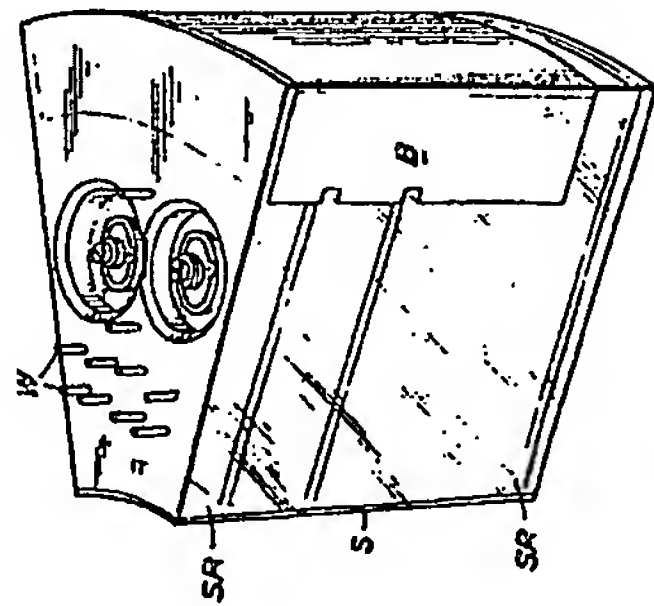


Fig. 3.

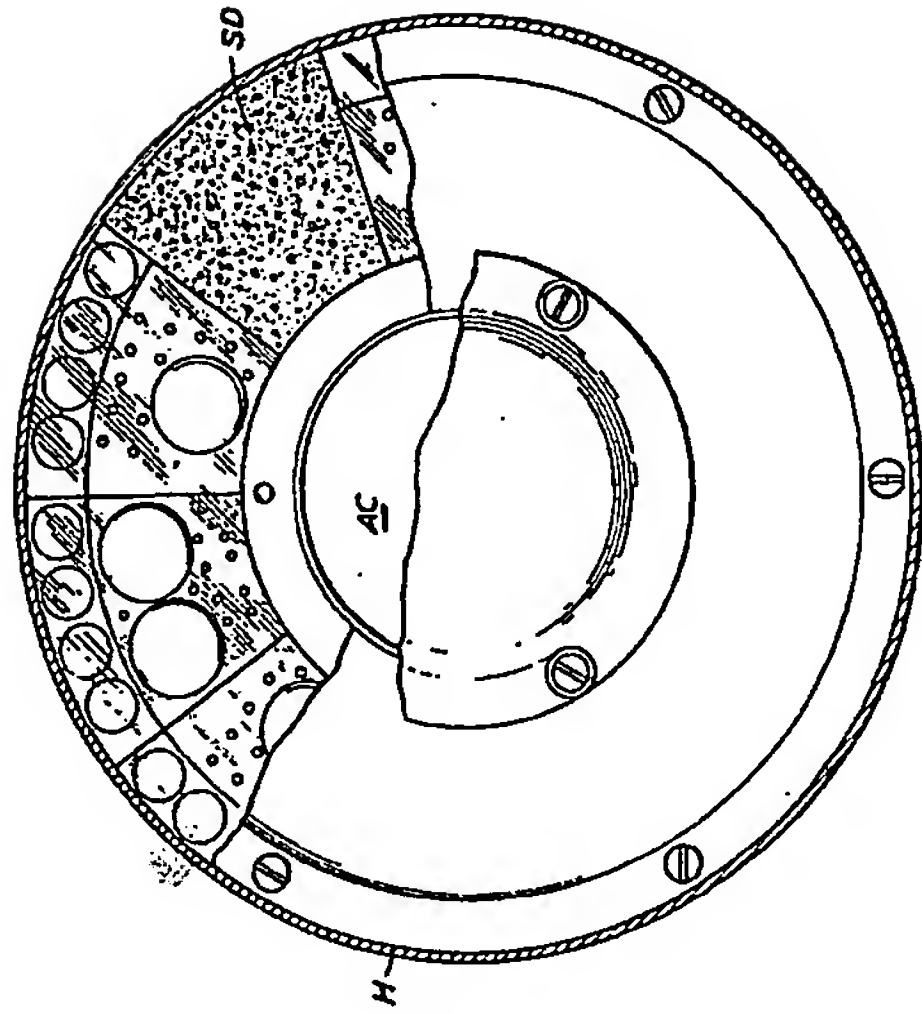


Fig. 4.